The Role of IT in Enterprise Transformation

Presented by
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Massachusetts Institute of Technology
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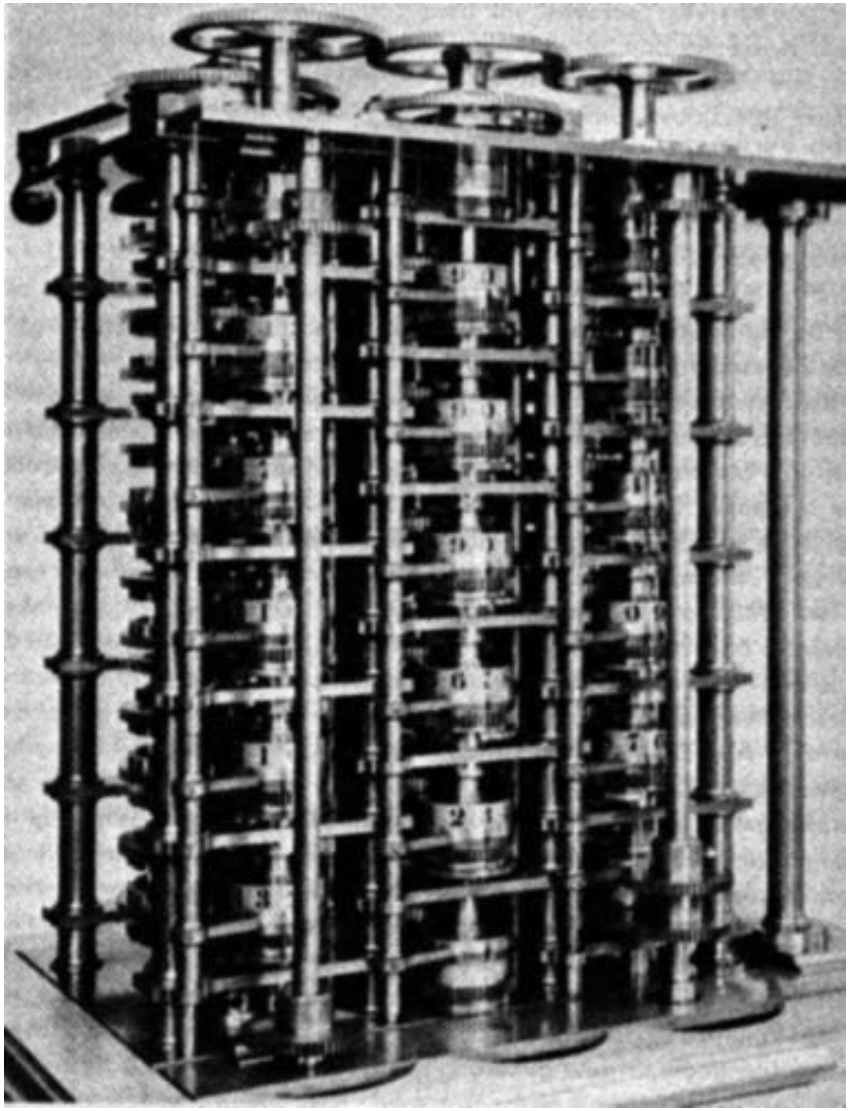
Today

- A brief history of Computing
- Deciphering the Alphabet Soup
- Strategic Frontiers
  - Information Systems
  - Enterprise Architecture
  - Software Development

That's a Computer?



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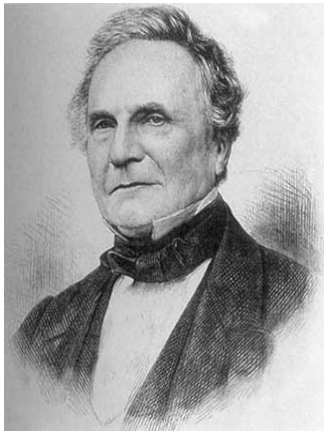
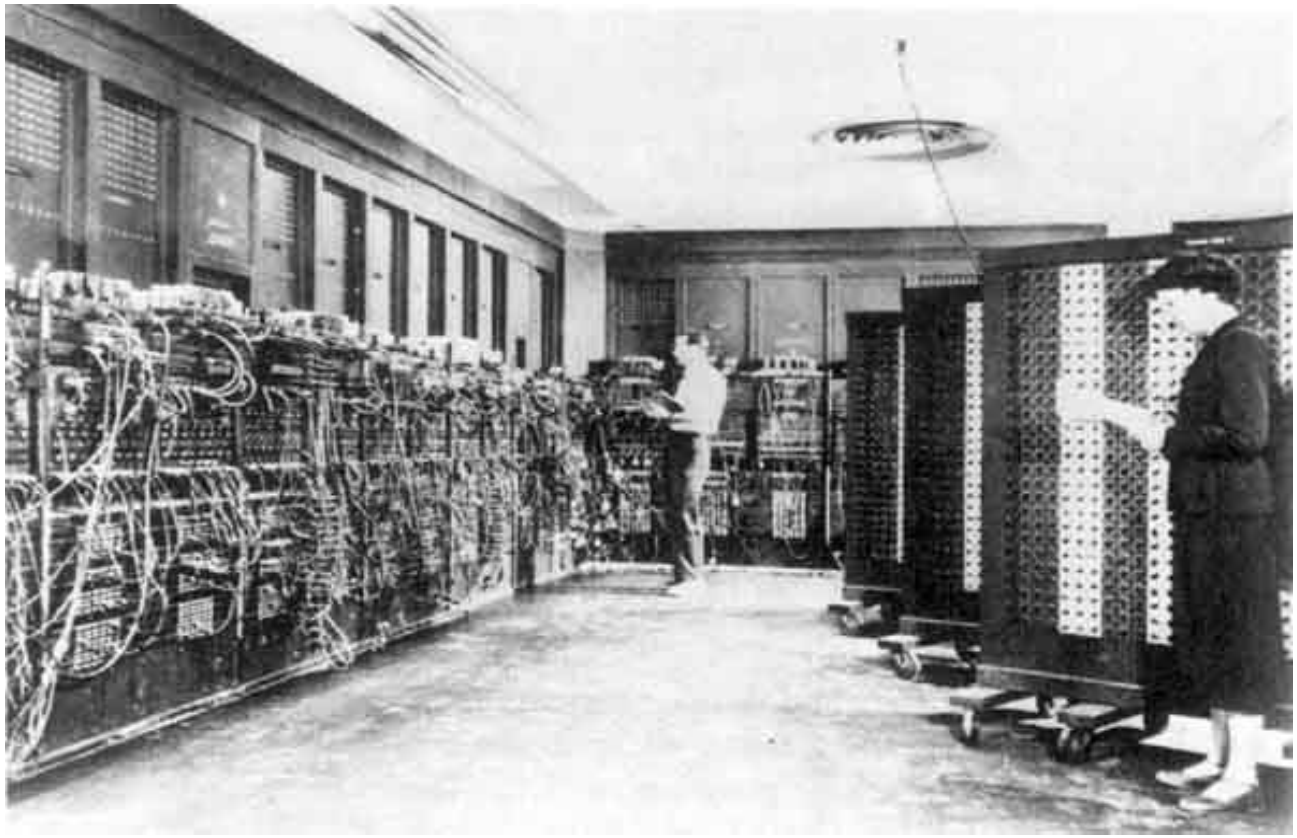


Now that's a Computer!

- 1945 - 1955
  - vacuum tubes, plug boards
- ENIAC



Historically Interesting Quotes

"This 'telephone' has too many shortcomings to be seriously considered as a means of communication. The device is inherently of no value to us."
Western Union internal memo, 1876.

"Computers in the future may weigh no more than 1.5 tons.“ -
Popular Mechanics, forecasting the relentless march of science, 1949

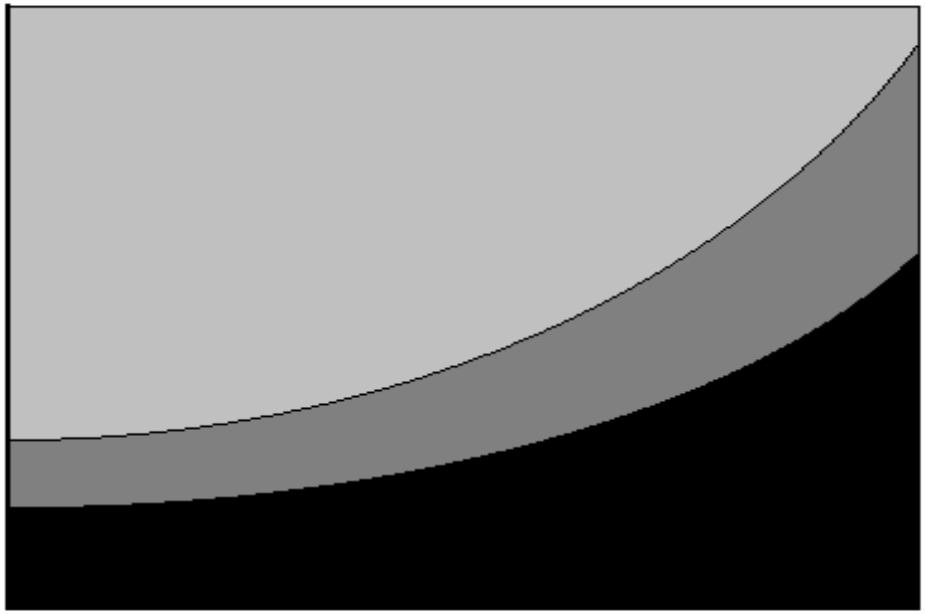
"I think there is a world market for maybe five computers.“ -
Thomas Watson, chairman of IBM, 1943

"I have travelled the length and breadth of this country and talked with the best people, and I can assure you that data processing is a fad that won't last out the year.“ - The editor in charge of business books for Prentice Hall, 1957

"But what ... is it good for?"
Engineer at the Advanced Computing Systems Division of IBM, 1968, commenting on the microchip.

"There is no reason anyone would want a computer in their home."
Ken Olson, president, chairman and founder of Digital Equipment Corp., 1977

Moore's Law In Action



Hardware Costs

Software Costs

Service Costs

1970 **2000**

Toffler's Three Waves of Change

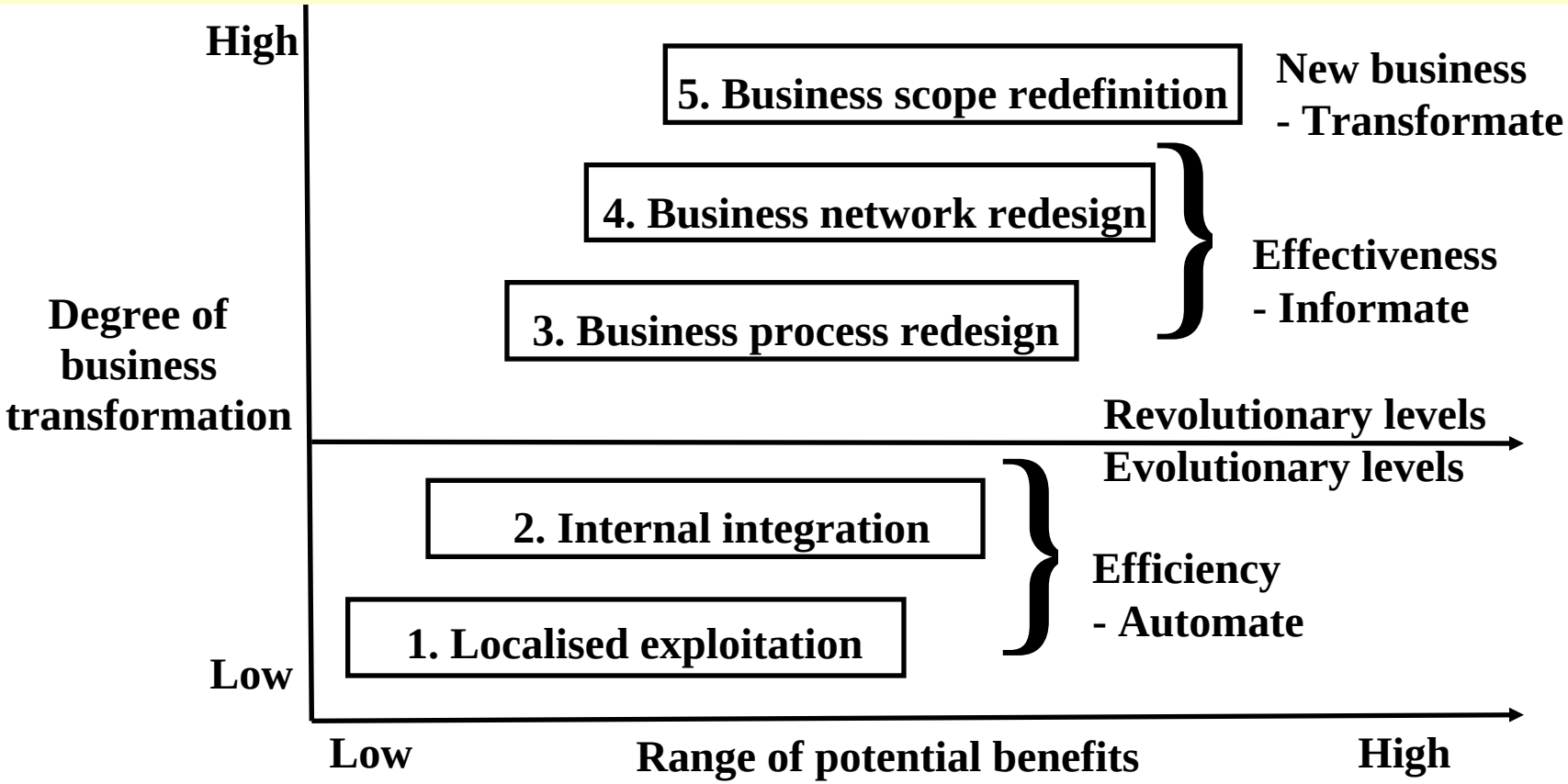
- **Agriculture**
- **Industrial**
- **Information**

"In 'The Third Wave' we wrote about the so-called commanding heights of industry, and that was the slogan of the Labor Party in Britain at the end of the war. 'We must capture the commanding heights.' Well the commanding heights they captured are no longer the commanding heights of industry, they were yesterday's commanding heights. The new commanding heights are knowledge-based, and that's why you see companies like Microsoft suddenly emerge out of nowhere and become huge" – Alvin Toffler*

***http://iranscope.ghandchi.com/Anthology/Alvin_Toffler98.htm**

Layers of Transformation

Discussion: Where are we Today?



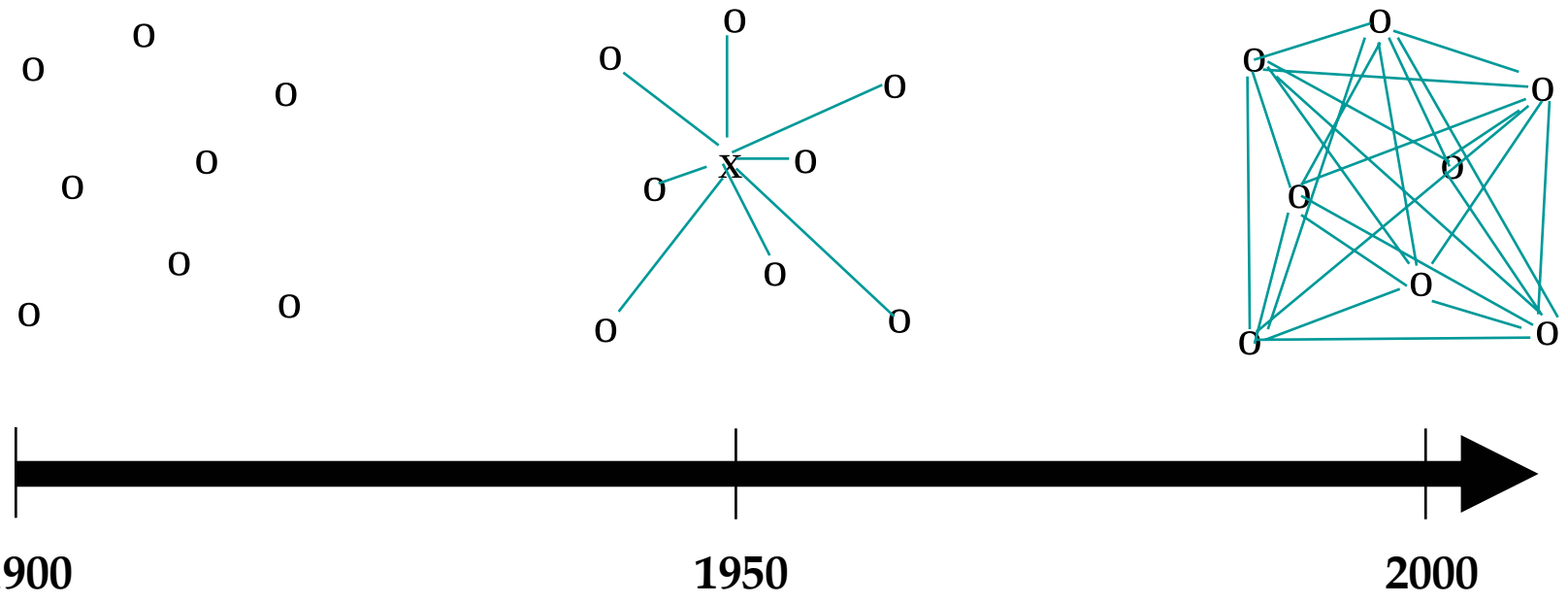
(Source: MIT90s)

Emergence of a complex networked enterprise

Small, local enterprises

Centralized hierarchical enterprises

Complex Networked Enterprises



Source: Thomas W. Malone, "Inventing the Organizations of the New Economy," Presentation at the Lean Aerospace Initiative Plenary Conference (March 2001)

Deciphering the Alphabet Soup

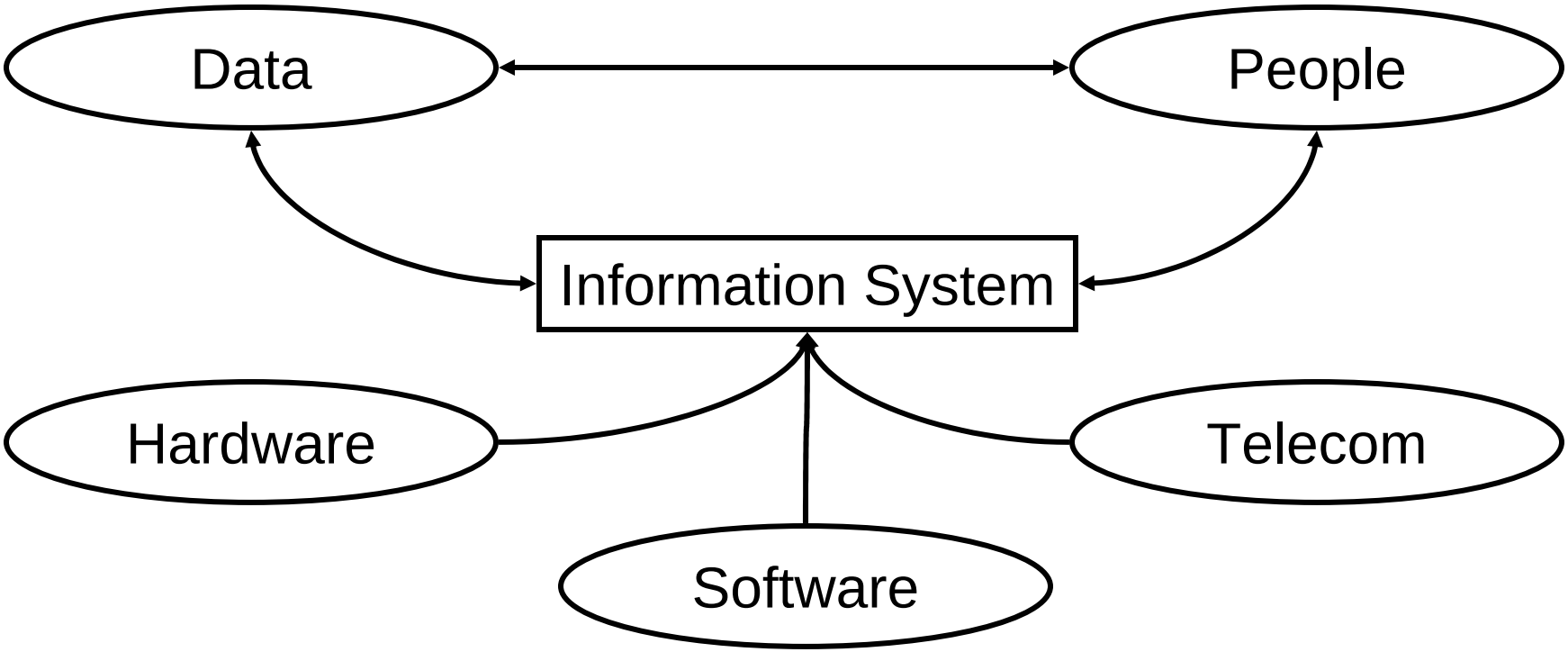
- **IT - structurally and operationally enable and facilitate information systems**
- **ITC - structurally and operationally enable and facilitate information systems AND communication**
- **IS - An organized combination of people, physical devices, information processing instructions, communications channels, and stored data that gathers, stores, uses and disseminates information in an organization**

The Pooh Analogy

Here is Edward Bear, coming downstairs now, bump, bump, bump, on the back of his head, behind Christopher Robin. It is, as far as he knows, the only way of coming downstairs, but sometimes he feels that there really is another way, if only he could stop bumping for a moment and think of it. -
Winnie-the-Pooh, A.A. Milne, 1926

Opinion Poll:
How many people here feel that way?

Components of an Information System



Evolution of IS

Inward Focus

- **Operations Support Systems**
  - **TPS – Transaction Processing Systems**
  - **PCS – Process Control Systems**

- **Management Support Systems**
  - **MIS - Management Information Systems**
  - **DSS - Decision Support Systems**
  - **EIS - Executive Information Systems**

Outward Focus

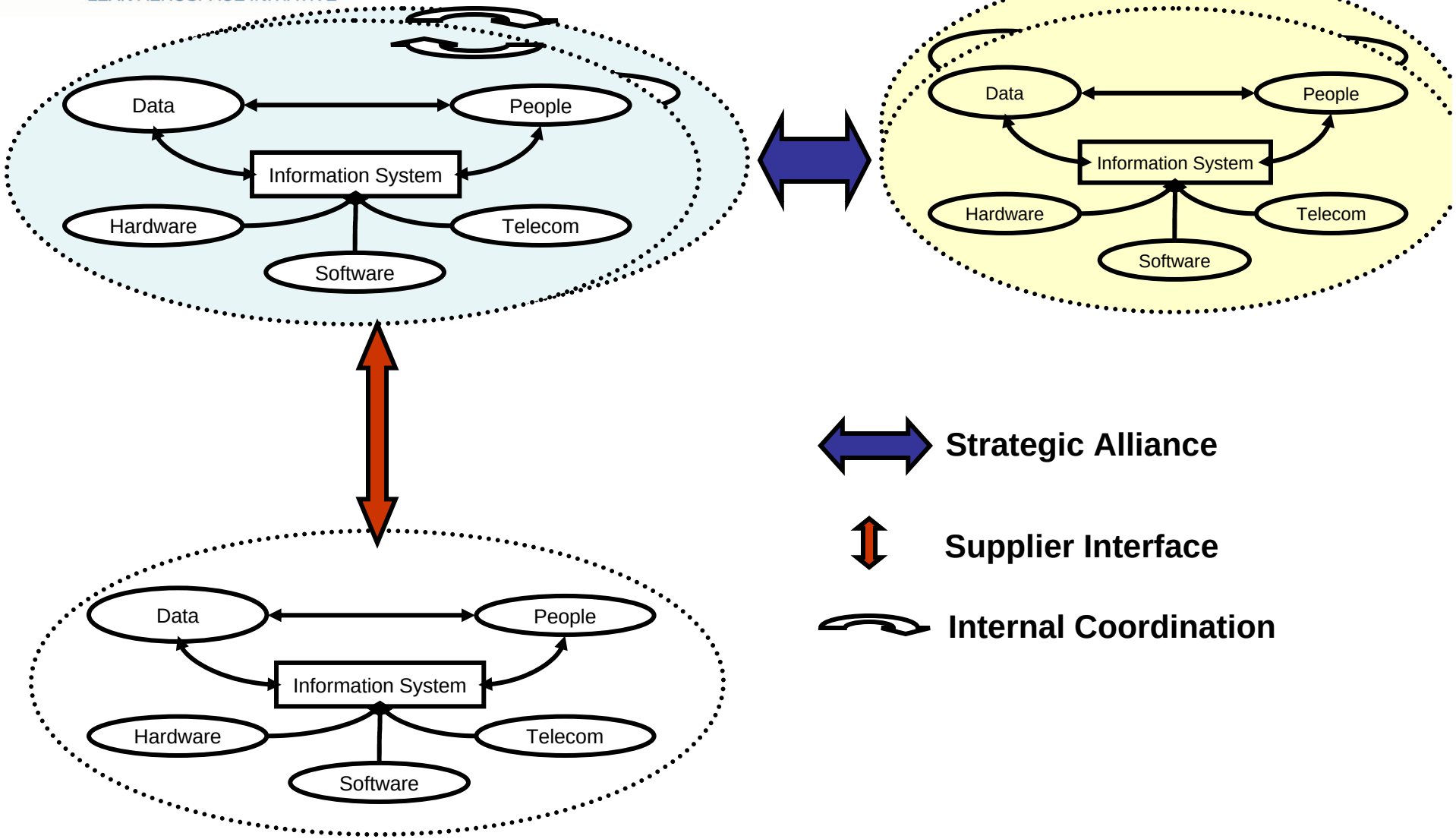
- **EWSMS - Enterprise Wide Strategic Management Systems**

The IS Timeline

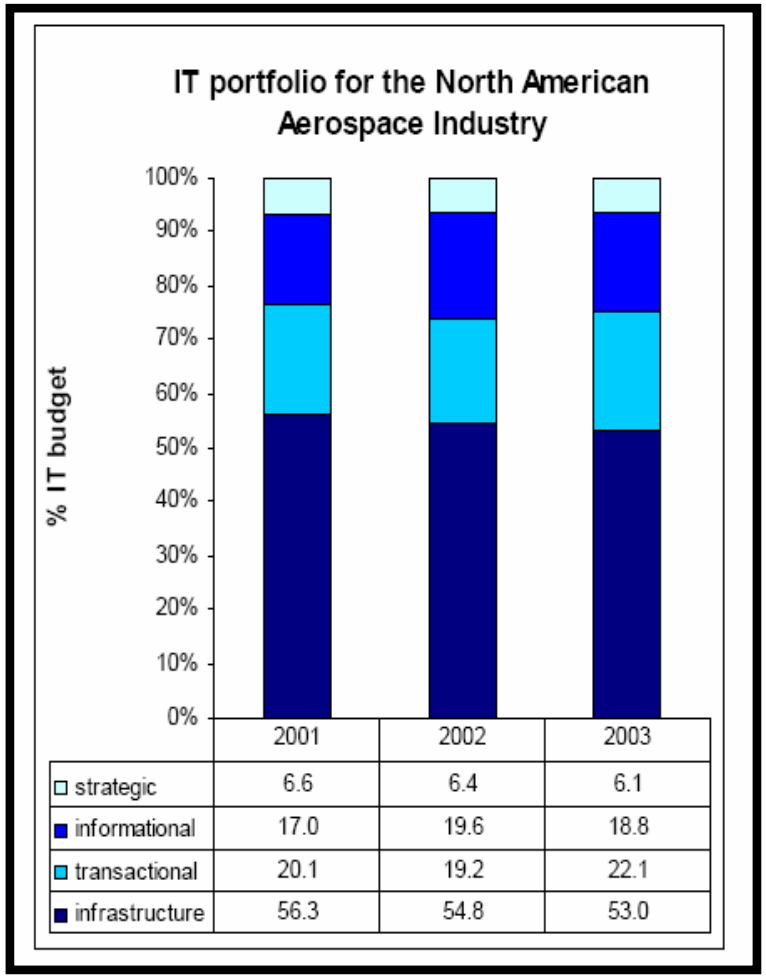
Era	Characteristics	When?
Data Processing (DP)	***Operational control systems Transaction processing***	***1960's →***
Management Information Systems (MIS)	***Control & planning systems Problem solving and decision support***	***1970's →***
Strategic Information Systems (SIS)	***Systems critical to business operations & competitive advantage***	***1980's →***
Enterprise Wide Strategic Management Systems (EW-SMS)	***IT/IS embedded in the organization Inseparable from enterprise Delivers** sustainable **competitive advantage***	***Now? →***

***Adapted from Ward & Peppard, Strategig Planning for Information Systems, John Wiley & Sons 2002**

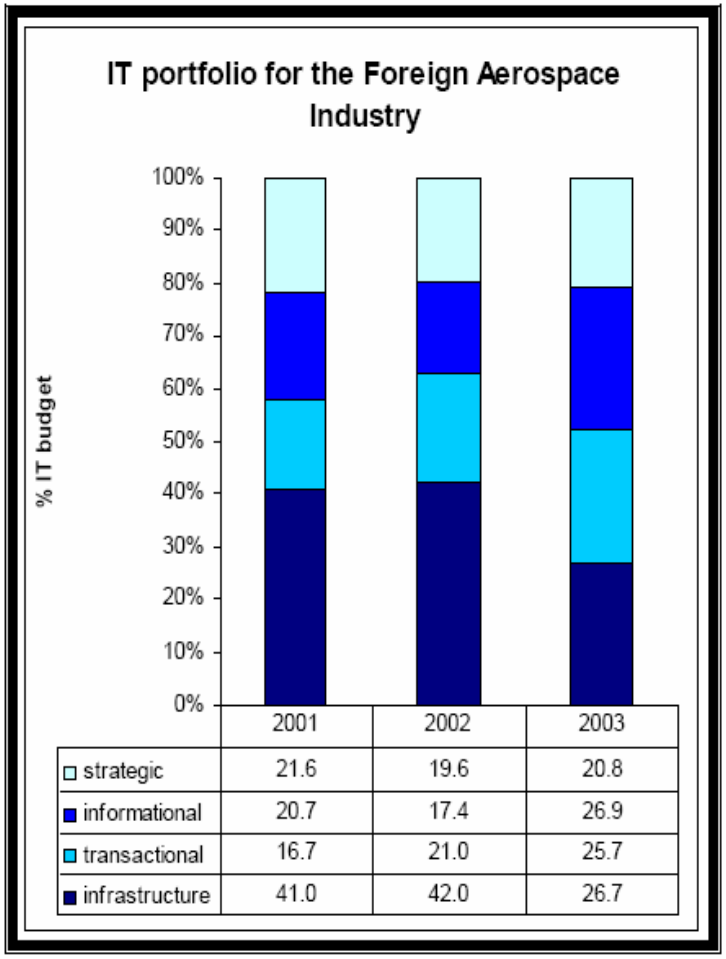
Current State



Current State Assessment



	2001	2002	2003
strategic	6.6	6.4	6.1
informational	17.0	19.6	18.8
transactional	20.1	19.2	22.1
infrastructure	56.3	54.8	53.0



	2001	2002	2003
strategic	21.6	19.6	20.8
informational	20.7	17.4	26.9
transactional	16.7	21.0	25.7
infrastructure	41.0	42.0	26.7

Source: Gregoire Ferre, "IT Management In the Aerospace Industry", SM Thesis, MIT 2004

Top 3 Risks in IS Implementation

- **Lack of top management commitment to the program**
- **Misunderstanding the requirements**
- **Failure to gain user commitment**

"Like other chief executives, I feel I'm being blackmailed. Not just by the suppliers, I expect that. But by my own IT staff who never stop telling me what the competition are spending ..."

- ***Grindley K, Managing IT At Board Level, Pitmans Publishing, p58, 1991.***

DISCUSSION: How do we get top management commitment?

IT Governance Archetypes

- Business Monarchy
- IT Monarchy
- Feudal
- Federal
- Duopoly
- Anarchy

DISCUSSION: What really Works and Why?

Research Findings

Decision Making

Decision	IT Principles	IT Architecture	IT Infrastructure	Business App Needs	IT Investments
Business Monarchy	4			2	4
IT Monarchy	2	6	7	3	1
Feudal					
Federal	1	1	1	2	2
Duopoly	2	2	1	2	2

Input Provision

Input	IT Principles	IT Architecture[36]	IT Infrastructure	Business App Needs	IT Investments
Business Monarchy		1	1		
IT Monarchy		1	1		
Feudal		1	2		2
Federal	5	4	4	8	3
Duopoly	4	1	1	1	4

Most preferred pattern within the aerospace segment

Second most preferred pattern within the aerospace segment

Most preferred pattern according to surveys analyzed by CISR

Number of Aerospace Industry companies identified with such a pattern

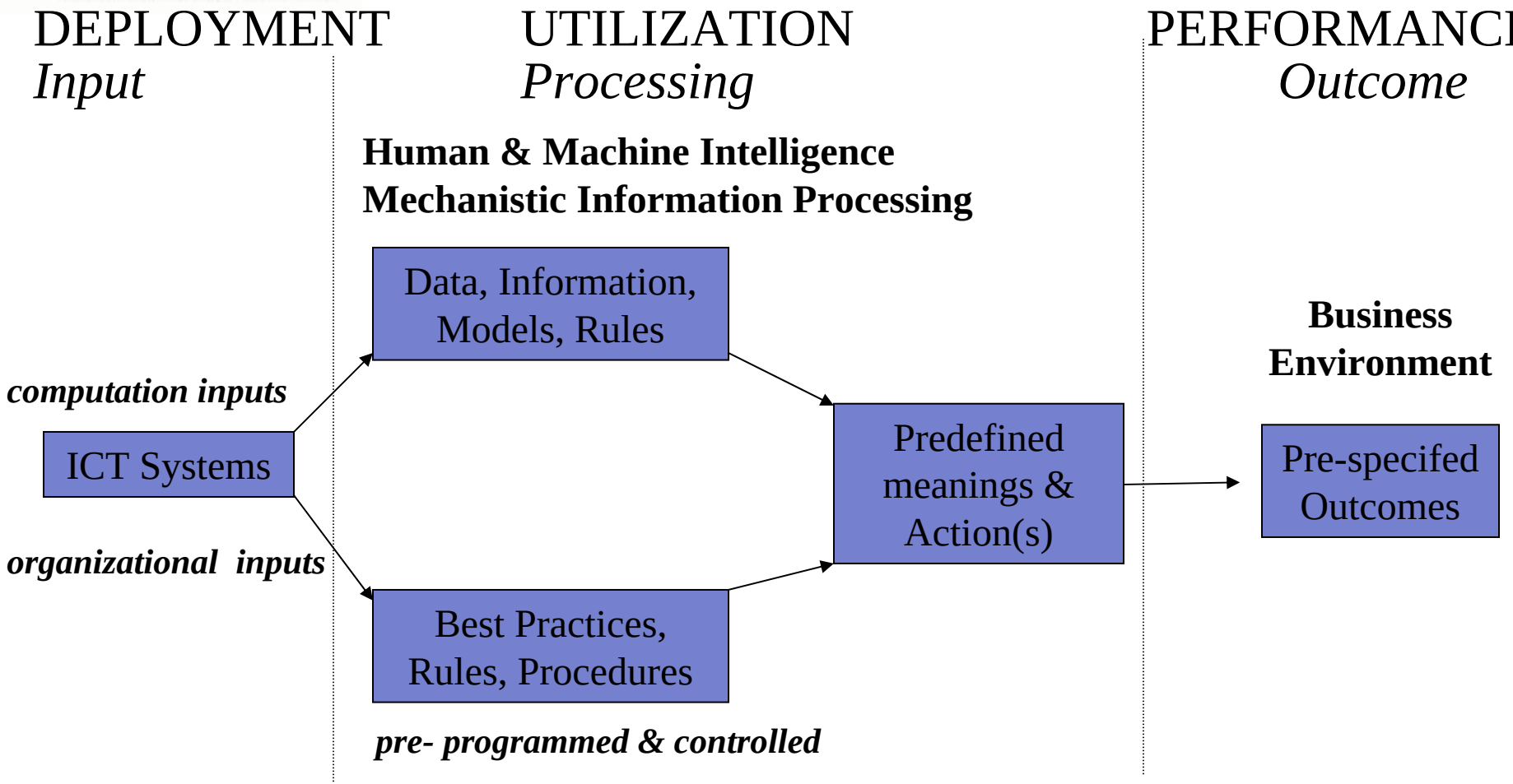
Source: Gregoire Ferre, "IT Management In the Aerospace Industry", SM Thesis, MIT 2004

Misunderstanding Requirements

- Technology push versus Strategic Pull
- Lack of internal capability
- Immature system design and development processes

DISCUSSION: How do we get it right?

Technology Push



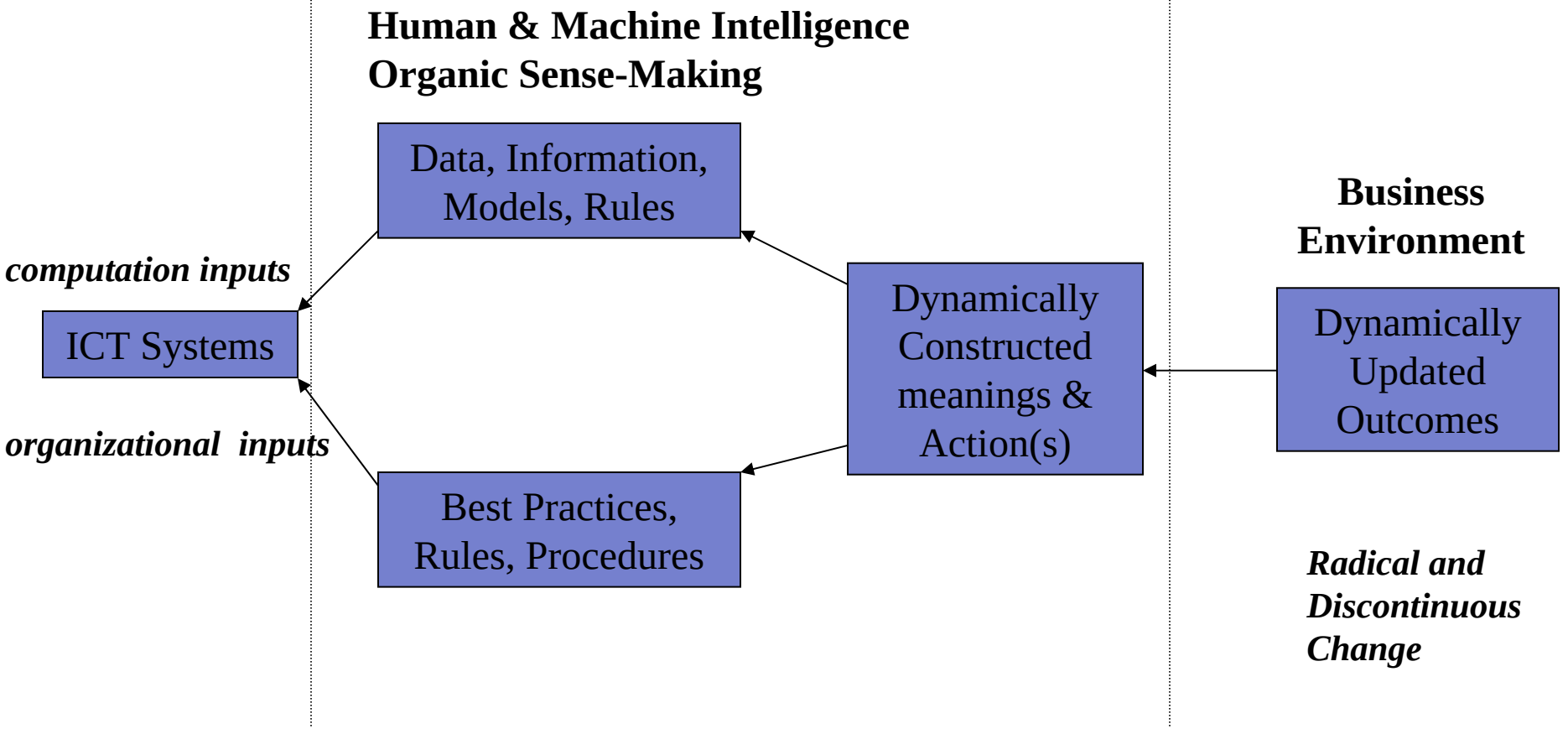
Adapted from: **Malhotra, Y.**, ***Integrating Knowledge Management Technologies in Organizational Business Processes: Getting Real Time Enterprises to Deliver Real Business Performance*****, Journal of Knowledge Management, (forthcoming).**

Strategy Pull

DEPLOYMENT *Input*

UTILIZATION *Processing*

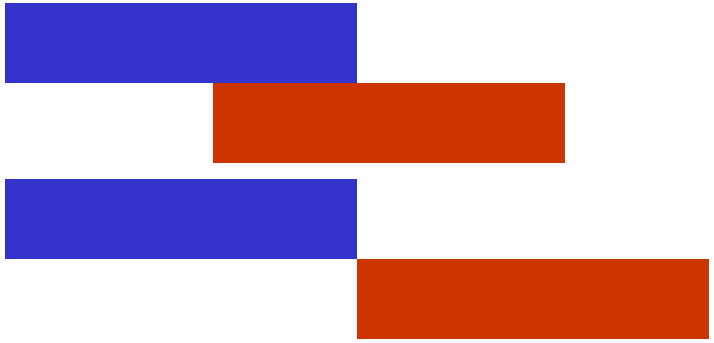
PERFORMANCE *Outcome*



Adapted from: **Malhotra, Y.**, ***Integrating Knowledge Management Technologies in Organizational Business Processes: Getting Real Time Enterprises to Deliver Real Business Performance*****, Journal of Knowledge Management, (forthcoming).**

Getting User Commitment

- Parallel

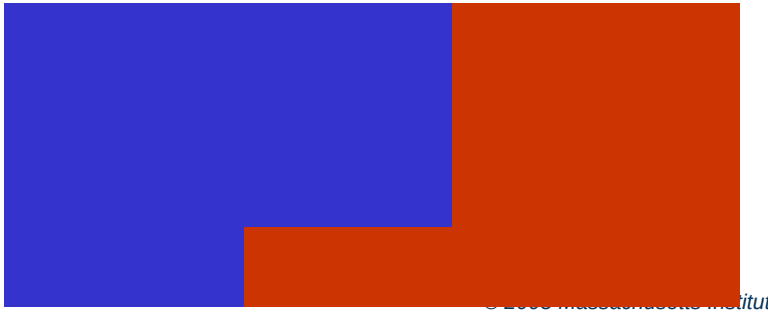


- Direct

DISCUSSION: How do we get user commitment?

- Phased

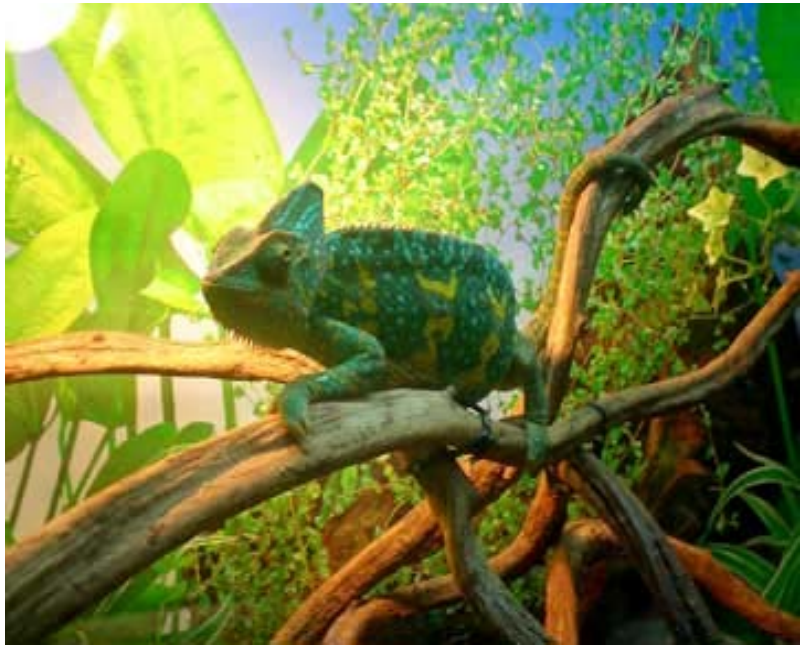
- Pilot



The Successful CIO

- **Attributes of a successful CIO**
  - **Versatility**
  - **Vision**
  - **Quickness**
  - **Tenacity**

- **Multi-dimensional**
  - **A technology champion**
  - **A business strategist**
  - **A technologist**
  - **A leader**
  - **An integrator**
  - **A friend to all …**



IT View: Enterprise Architecture

- Data-Centric
- Process-Centric
- Secure
- Light-weight/Open
- Pervasive
- Service Oriented
- Needs-based

Enterprise Architecture

"... the set of descriptive representations (i.e. models) that are relevant for describing an Enterprise such that it can be produced to management's requirements (quality) and maintained over the period of its useful life (changed)" - John Zachmann

"an enterprise-wide architecture that captures common architectural decisions that are common and enforced across all applications and data centers within an enterprise" – Open Process Framework

DISCUSSION: What does an Enterprise Architecture Mean?

EA Usage

- Managing the complexity of the enterprise
- Enable better decision making
- Enable better budget prioritization
- Manage change through roadmap creation and monitoring
- IT focused

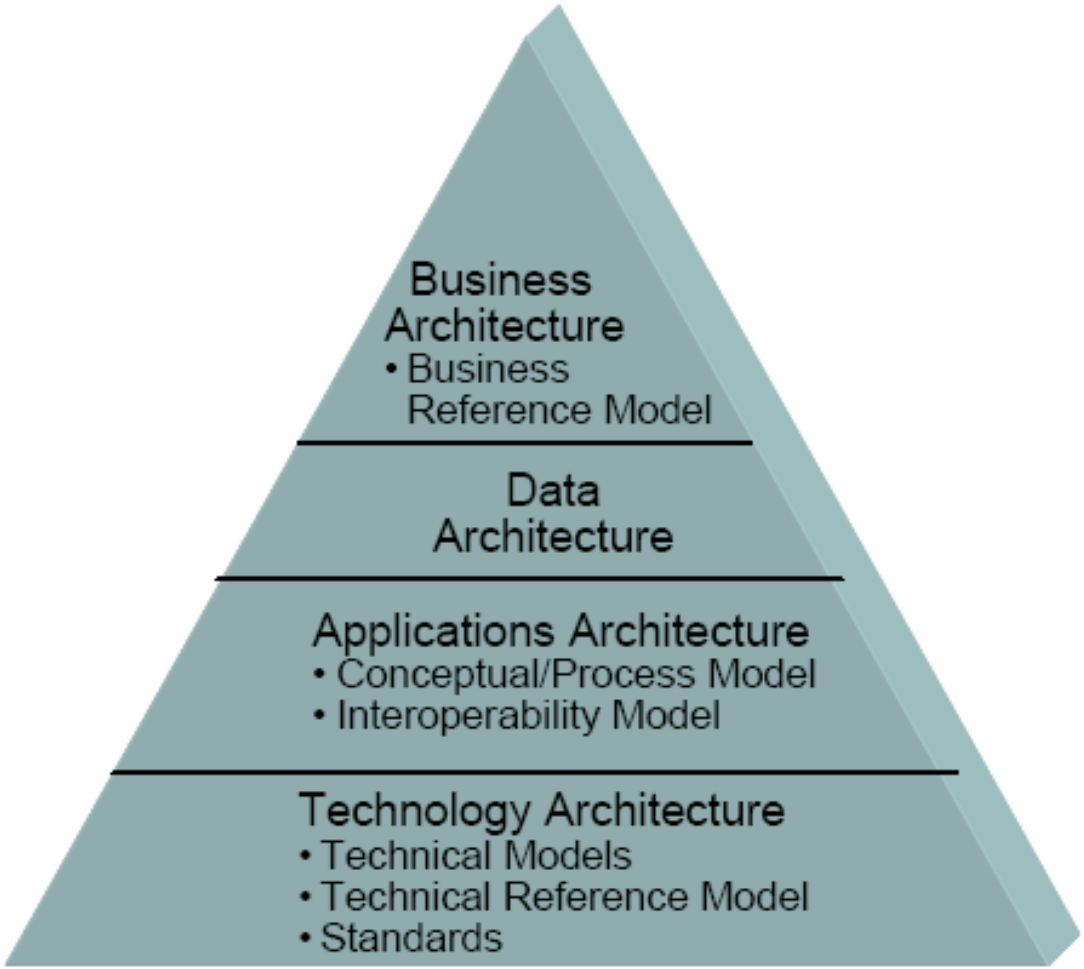
FEA: Federal Enterprise Architecture

- **The Federal Enterprise Architecture (FEA) is a function-driven framework for describing the business operations of the Federal Government independent of the Agencies that perform them.**

- **The Federal Enterprise Application Framework (FEAF), V1.1 provides various approaches, models, and definitions for communicating the overall organization and relationships of architecture components required for developing and maintaining the FEA.**

Source: E-Gov Enterprise Architecture Guidance, FEA Working Group

FEAF Overview



FEAF Architecture Principles

- Establish Federal interoperability standards
- Coordinate technology investments with the Federal business and architecture
- Minimize the data collection burden
- Secure Federal information against unauthorized access
- Take advantage of standardization based on common functions and customers
- Provide access to information
- Select and implement proven market technologies
- Comply with the Privacy Act of 1974.

EA Discussion

DISCUSSION: Who Drives the Creation and Management of the Enterprise Architecture?

DISCUSSION: What are the Guiding Principles for Aerospace?

DISCUSSION: Should it remain an IT Issue?

DISCUSSION: Who should maintain it?

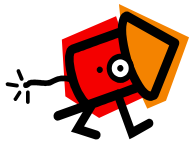
Setting the Context for Software Development

"Wicked problems are problems that are fully understood only after they are solved the first time."

- Rittell and Webber, Dilemmas in a general theory of planning, 1983

Software is a wicked problem…

- DeGrace and Stahl, "Wicked Problems, Righteous Solutions, A Catalogue of Modern Software Engineering Paradigms.", Prentice-Hall 1980



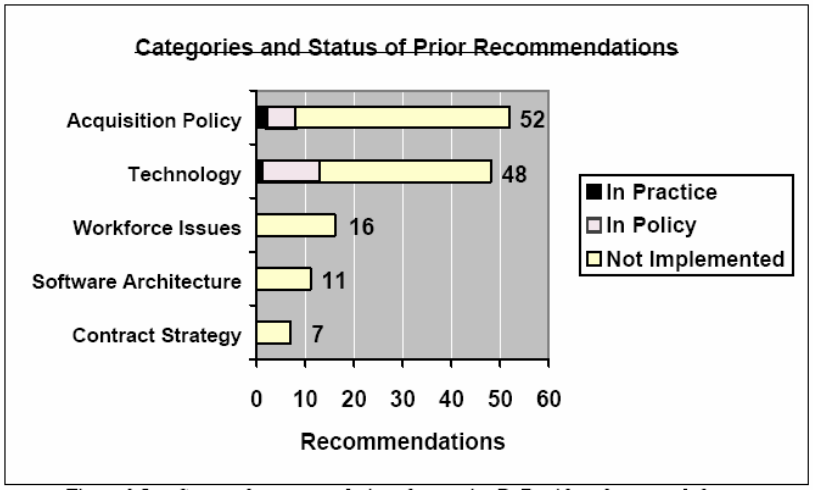
http://www.cnn.com/WORLD/9606/04/rocket.explode/

Motivation

- **Software is one of the key determinants of mission capability**
- **Used as a universal integrator**
- **Significant gaps between identified problems and corrective action**
- **CMM good but not sufficient**

Weapon System	Year	% of Functions Performed in Software
F-4	1960	8
A-7	1964	10
F-111	1970	20
F-15	1975	35
F-16	1982	45
B-2	1990	65
F-22	2000	80

Source: PM Magazine



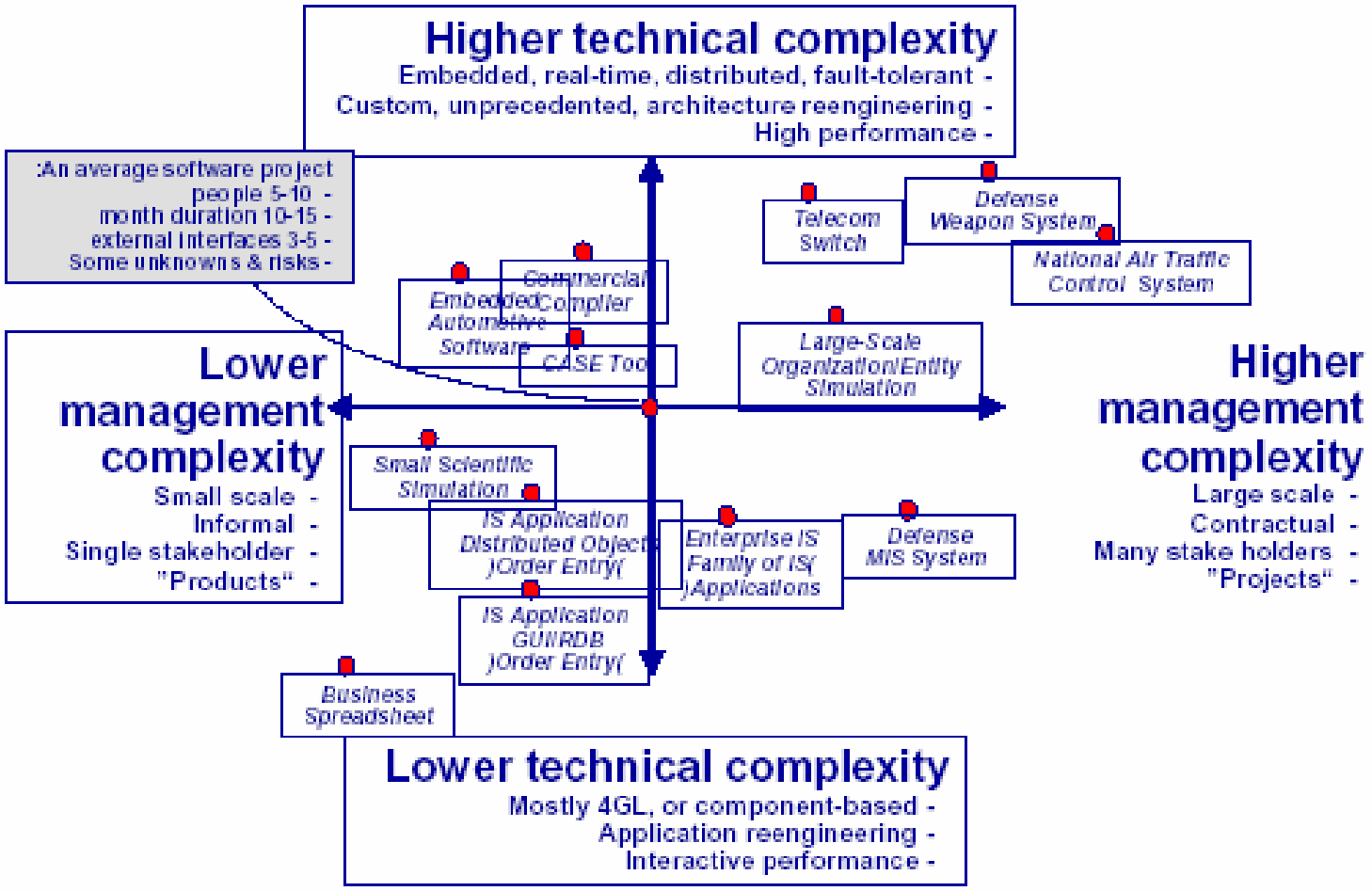
"Provide an effective framework for managing the acquisition of large-scale software development and maintenance programs that are an essential part of our increasingly complex weapon systems."
— Jennifer Jones

Software Acquisition Guidelines

DoD 5000.1 recognizes that software is a critical element in DoD systems. It states that *it is critical that software developers have:*

- A successful past performance record,
- Experience in the software domain or product line,
- A mature software development process, and
- Evidence of use and adequate training in software methodologies, tools, and environments.

Technical vs. Managerial Complexity



SOURCE: RATIONAL.COM HTTP://WWW.RATIONAL.COM/PRODUCTS/WHITEPAPERS/390.JSP

Issues in Software Acquisition

- Ability of the program to establish and adhere to processes to meet program needs
- Requirements management
- Organization management

Software Development Trends

- **Flexible**
- **Open Source**
- **COTS**

Software Discussion

DISCUSSION: Does process maturity matter?

DISCUSSION: Does the COTS Mandate help?

DISCUSSION: How do we handle rapid upgrade requirements while meeting –ilities?

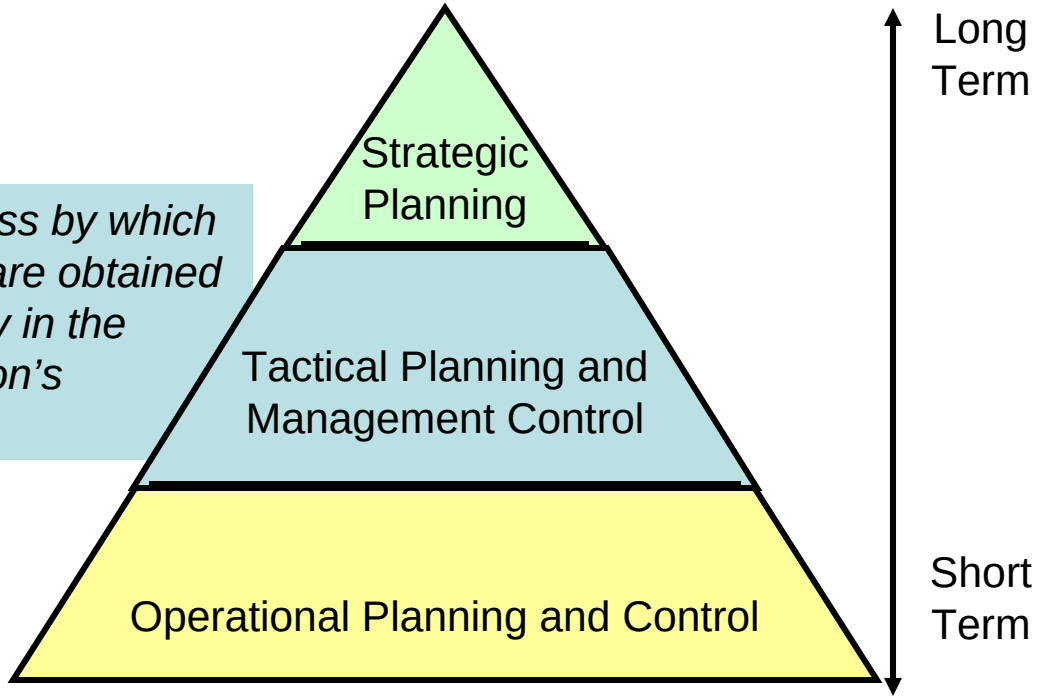
DISCUSSION: Is software development a core competence?

Backups

The Management Hierarchy

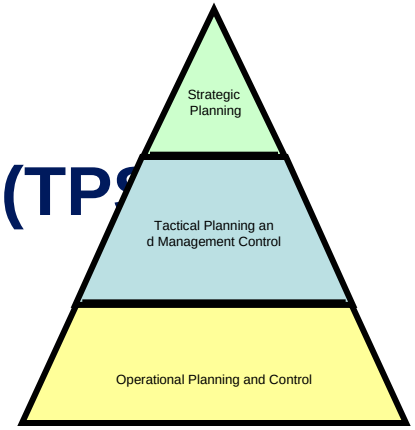
Strategic planning: process of deciding on objectives of the organization, on changes in these objectives, on the resources used to attain these objectives, and disposition of these resources"

"Management control is the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives"



" Operational control is the process of assuring that specific tasks are carried out effectively and efficiently"

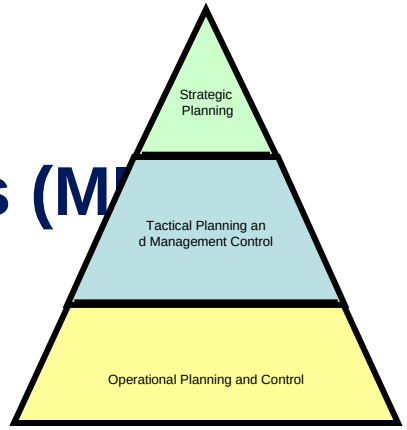
Mapping Information Systems



- **Transaction Processing Systems (TPS**
  - **Online processing**
  - **Batch Processing**

- **Automate repetitive information processing activity**
  - **Increase speed**
  - **Increase accuracy**
  - **Greater Efficiency**

Mapping Information Systems



- **Management Information Systems (MI**
  - **Managing Information Systems**
  - **Information for Mid-Level Managers**

- **Provide reports**
  - **Key-indicator report, Exception report, Drill-down report etc.**

- **Examples:**
  - **Sales forecasting, Financial Management and Forecasting, Inventory Management, Manufacturing Planning etc.**

Mapping Information Systems

- **Executive Information Systems (EIS)**
  - Used at the strategic Level
  - Highly Aggregated Information
- **Hard and Soft Data**
  - Facts, News
- **Examples:**
  - Long range planning, Crisis Management

Functional Information Systems

- **Decision Support Systems (DSS)**
  - **Cross Layer Usage**
- **Designed to support organizational dec making**
  - **"What-if" analysis**
    - **For example: Microsoft Excel**
    - **Text and graphs**
  - **Models for each of the functional areas**

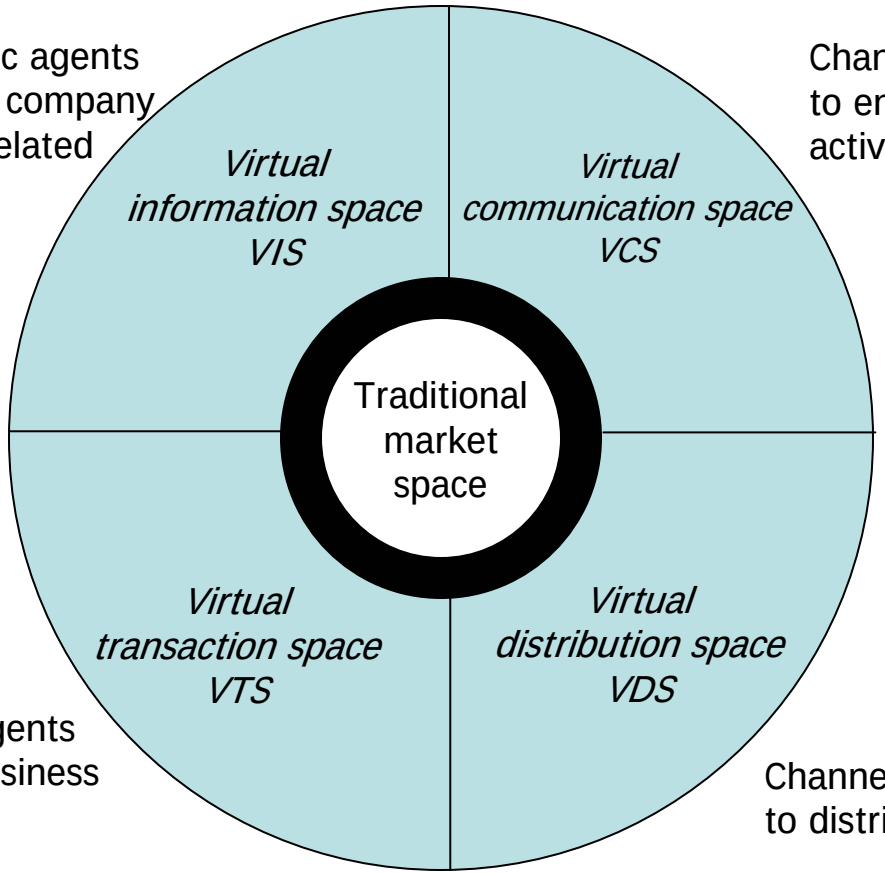
Enterprise Wide Strategic Management Systems

- **Enterprise Wide**
  - **Synergizes the organisation and its customers and suppliers**
- **Delivers competitive advantage**
  - **Built on a platform**
  - **Cannot be too quickly or easily copied**

The Four Virtual Spaces*

Channels for economic agents to display and access company product and service related information

Channels for economic agents to engage in relationship building activities

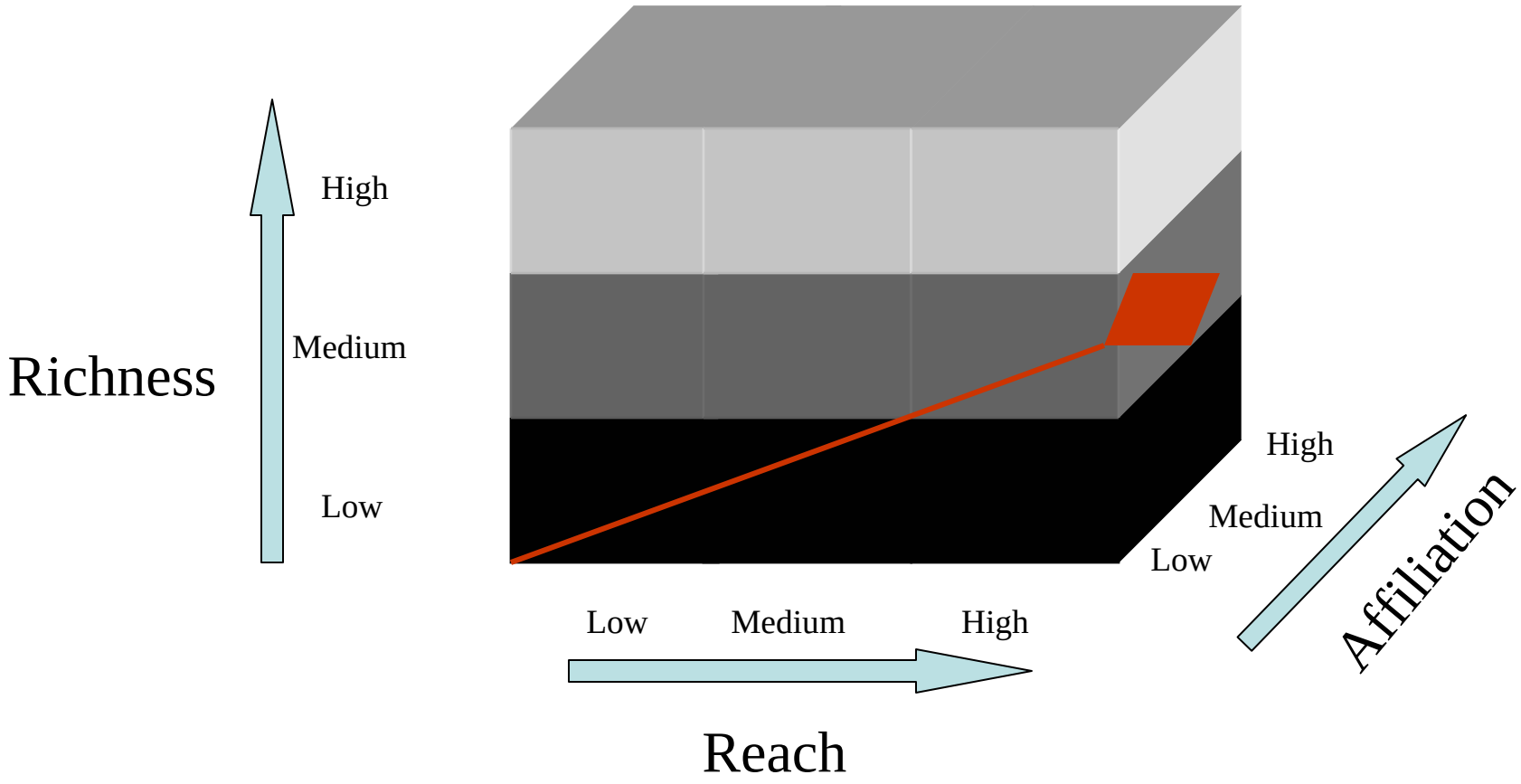


Channels for economic agents to initiate and execute business related transactions

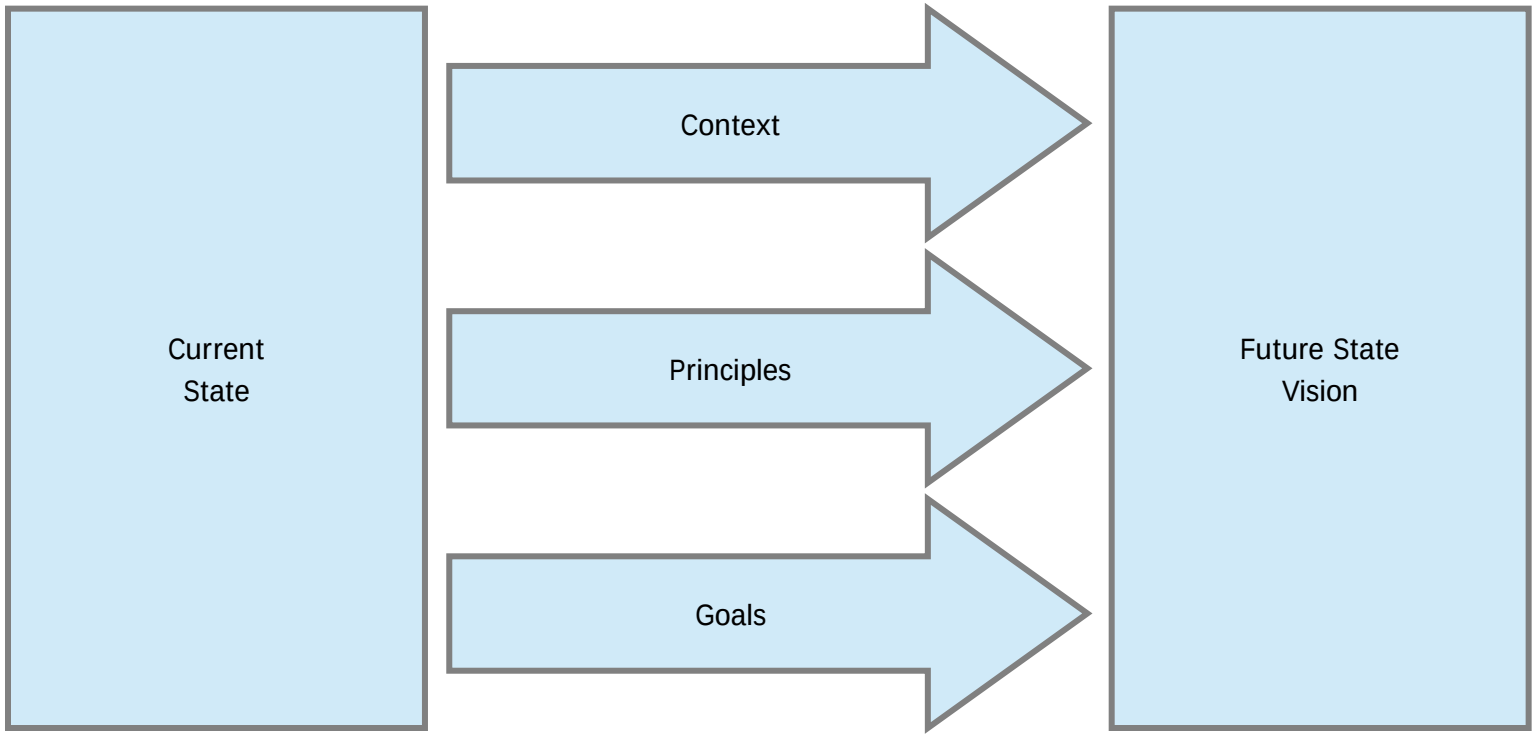
Channels for economic agents to distribute products and services

***Albert A. Angehrn, 1997; The ICDT Model: Towards a Taxonomy of Internet-related Business Strategies; 97/12 INSEAD/CALT Working Paper No. 5.**

The RRA Cube

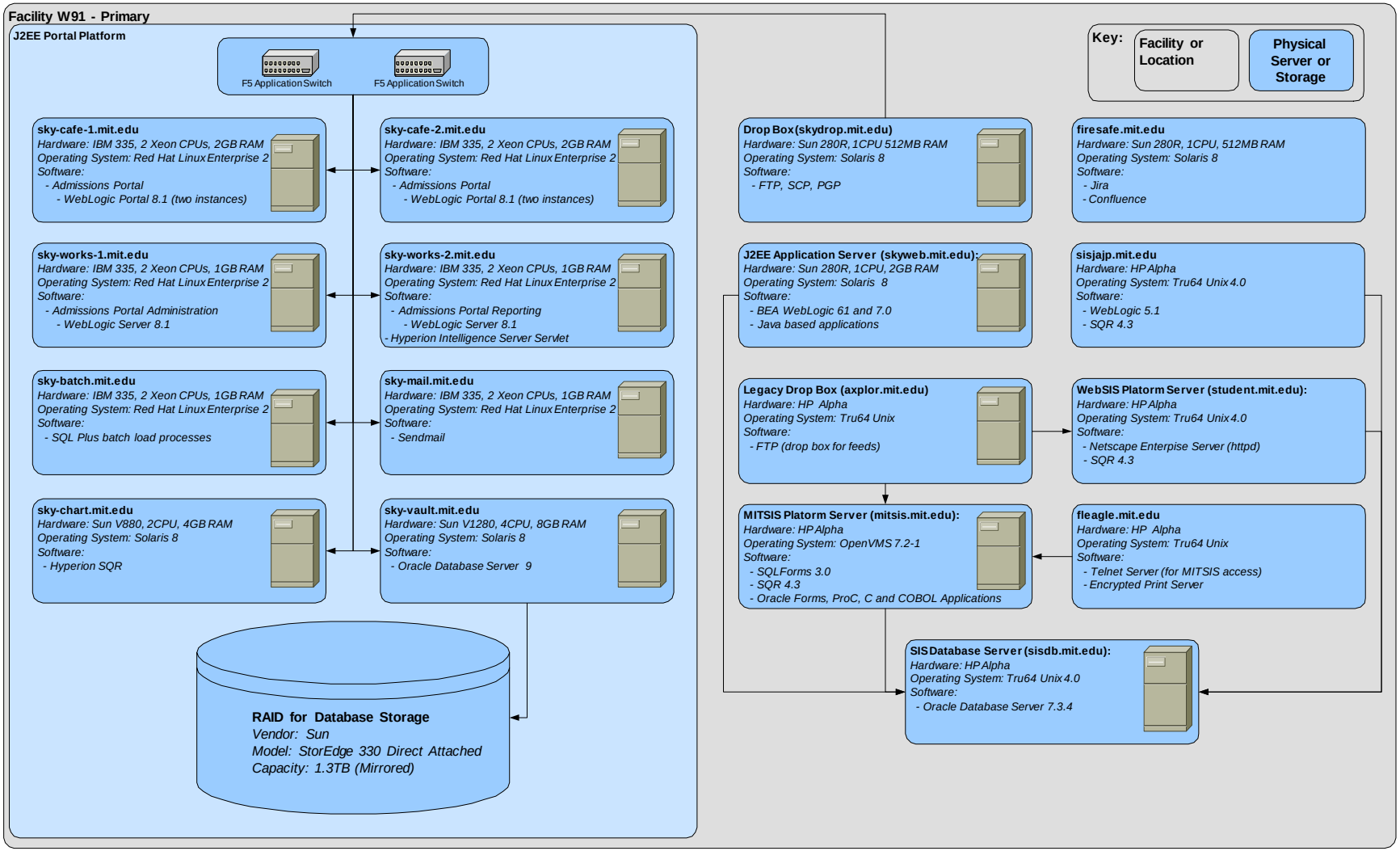


MIT Enterprise Architecture Guide Project

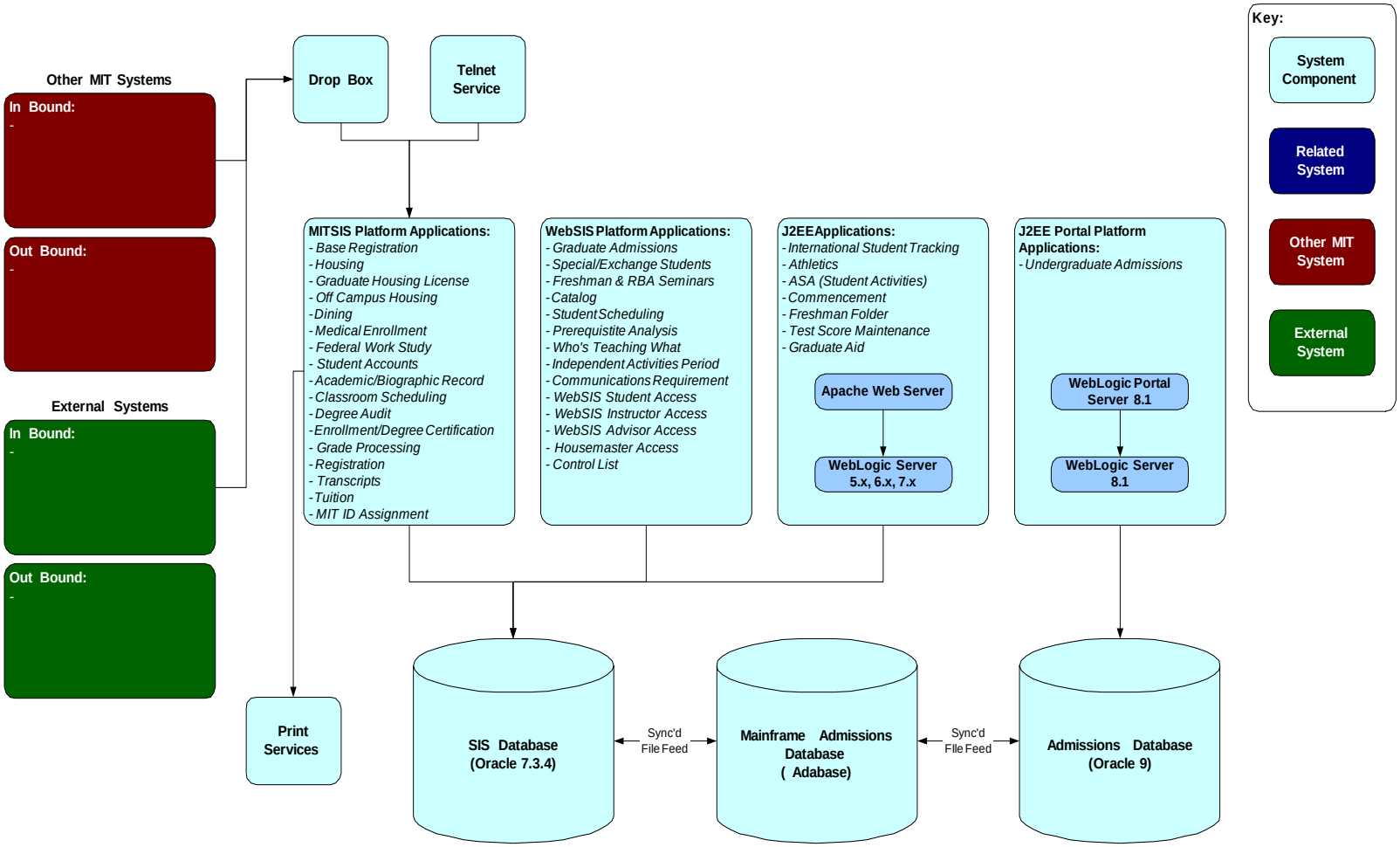


http://web.mit.edu/itag/eag/

Student Systems Physical Architecture



Student Systems Logical Architecture



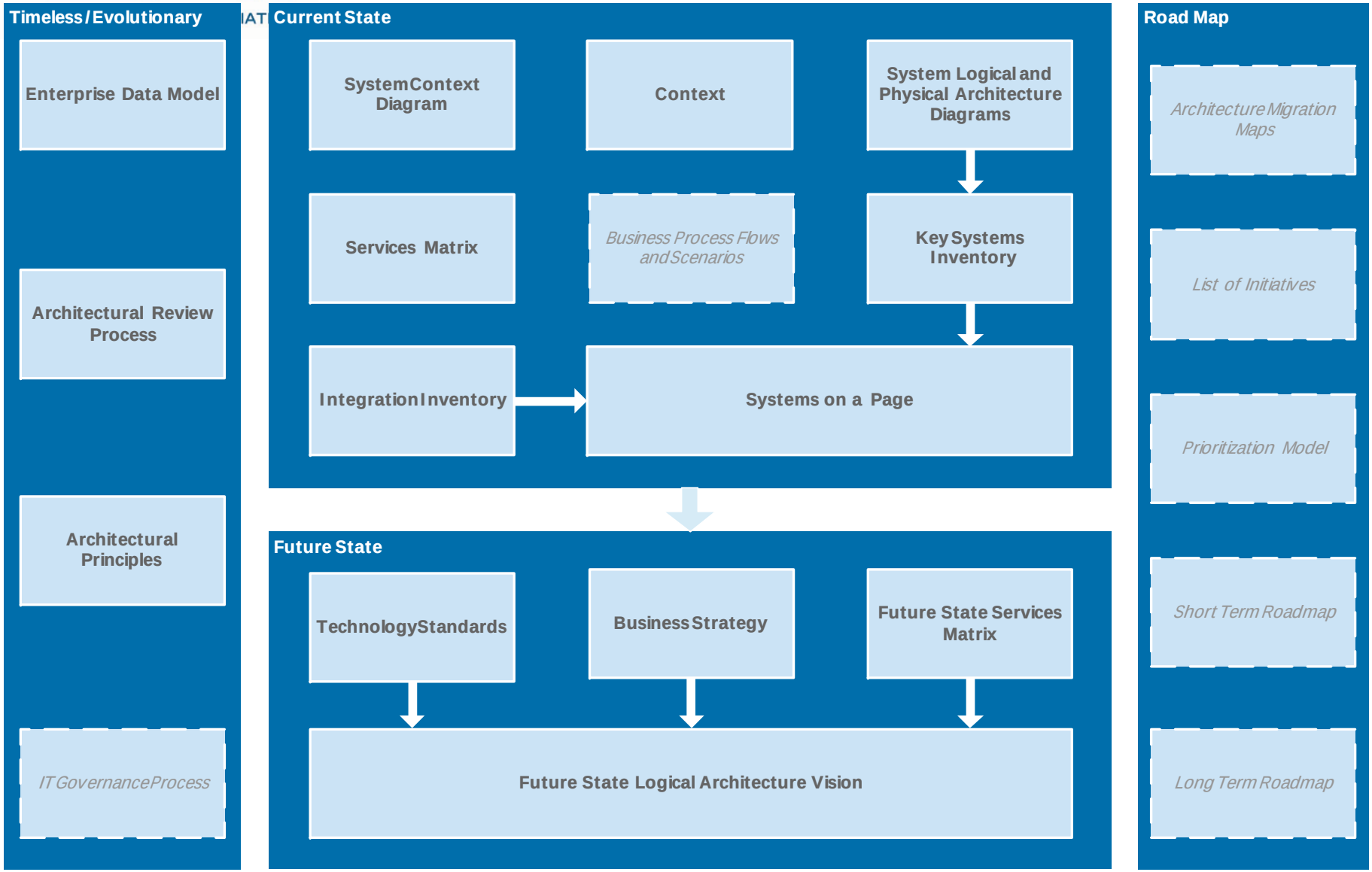
MIT Enterprise Architecture Guide

- Scope of Enterprise Architecture:
  - **Business processes and products, applications and data (Process)**
  - **Software and hardware infrastructure (Technology)**
  - **Knowledge and expertise (People)**
- Current State Assessment:
  - **Documentation review**
  - **Interviews with ITAG and departmental technology staff**
  - **Workshops to validate information gathered**
- Future State:
  - **Workshops (1/2 day) to cover:**
    - **Future State Context**
    - **Future State Principles**
    - **Logical Architecture Framework**
    - **Technology Standards**
    - **Services Matrix**
    - **Project Review process**
- Future Phases:
  - **Roadmap and Planning**
  - **Build-out**

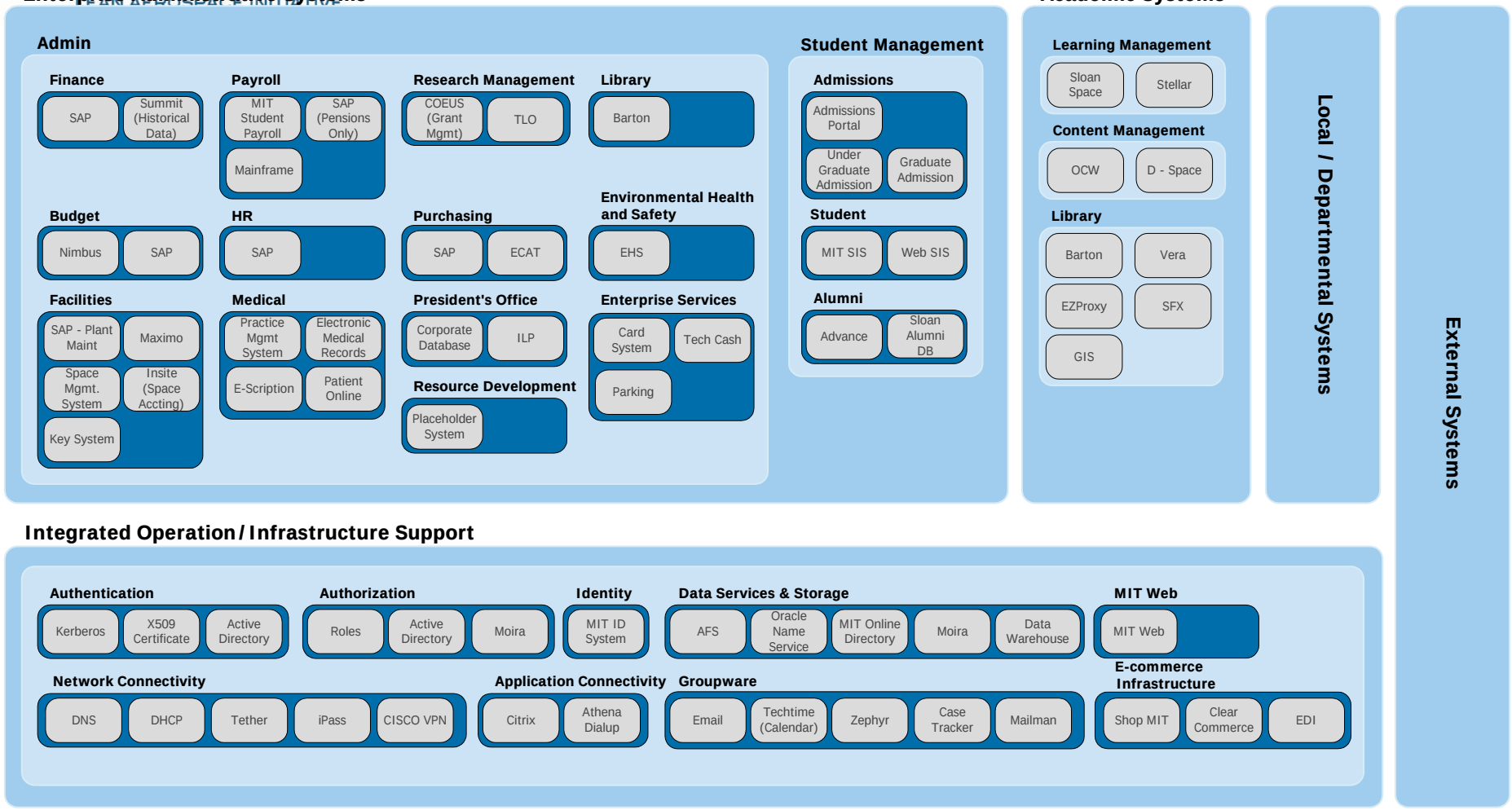
Architectural Principles

- Security: **applications should ensure data and access security**
- Ownership**: clear and explicit ownership of enterprise data**
- Leverage assets: **leverage existing services and capabilities**
- Accessibility: **be aware of to needs of all users (location & disabilities)**
- Real-time: **Minimize latency of data updates**
- Standards: **promote consistency using standards**

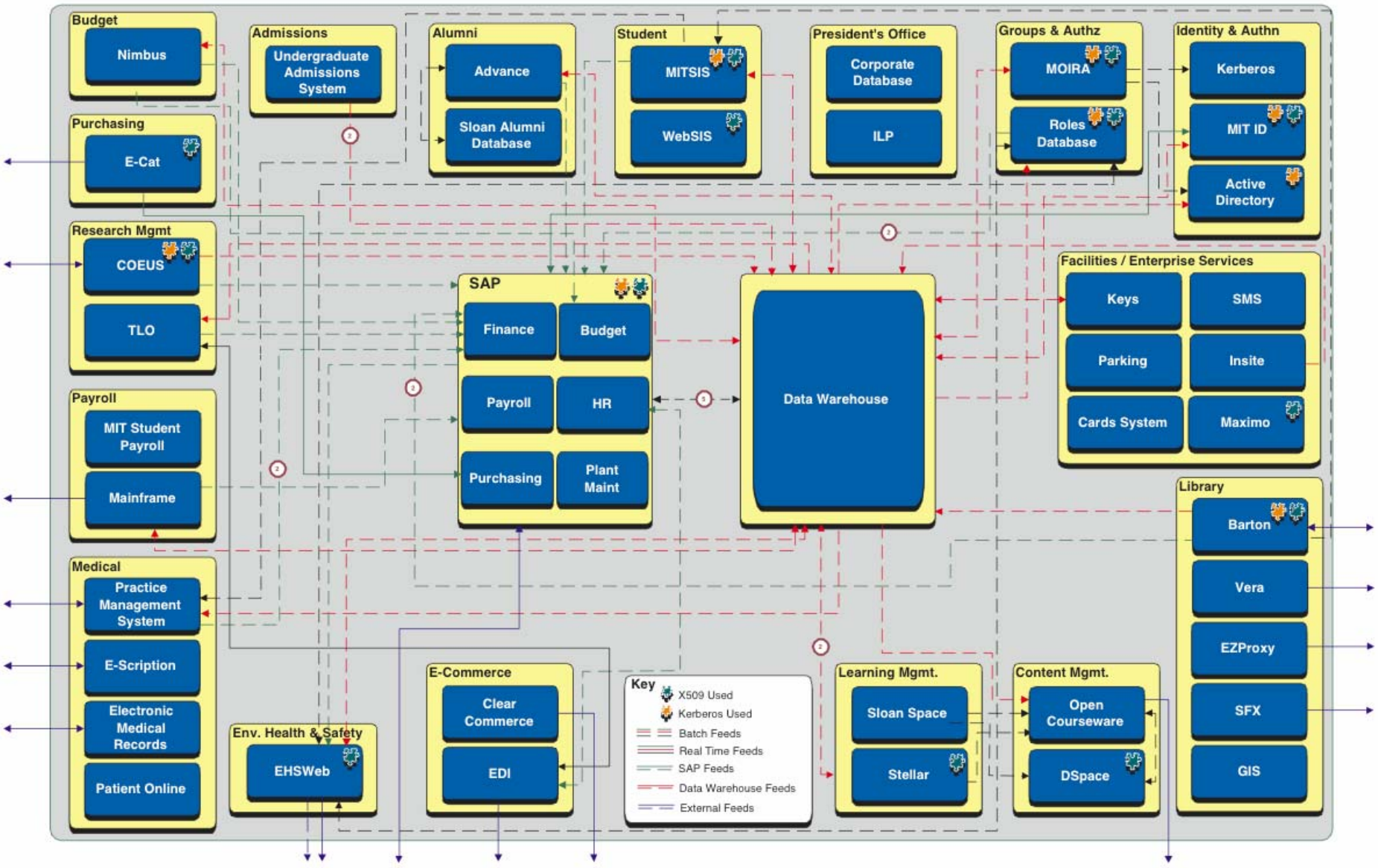
Enterprise Architecture Deliverables



Systems Context Diagram



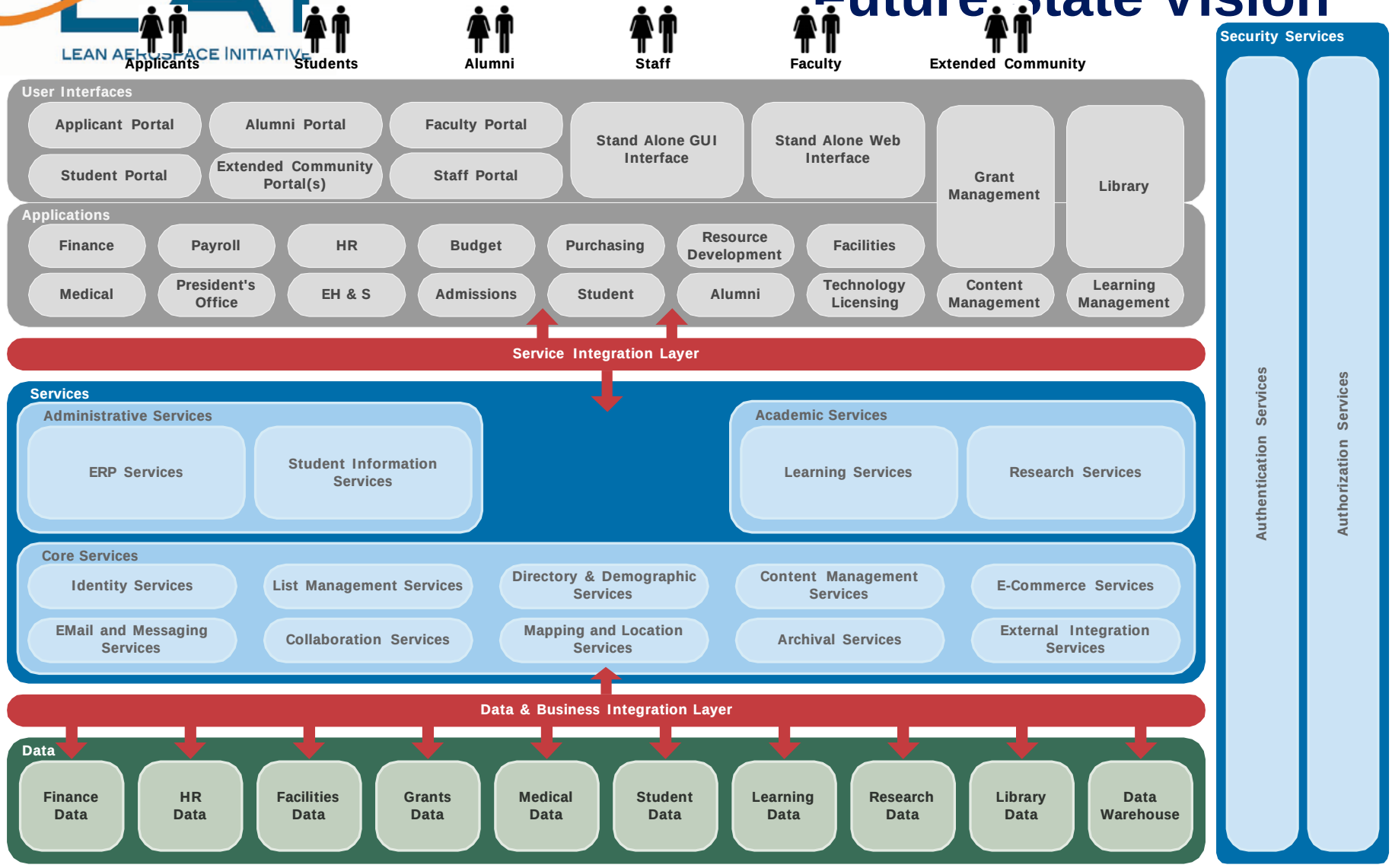
Current State



Future State Context

- SAP will continue to be the primary ERP system
- The MIT Data Warehouse will be the central repository for administrative data that is of interest to more than one DLC.
- The MIT community will continue to be global, 24x7 and evolving
- There will be increased integration between MIT and other universities
- The MIT environment is heterogeneous
- The MIT network will evolve to support needs of the enterprise
  - We may have many research networks
  - We will have an IPv6 network and we will need differentiated services to better support user needs

Future State Vision



Enterprise Integration Options

	EAI	Point to point	Web Services	ETL
Concept	• Publish/Subscribe mechanism • Most suitable for real time data needs • Loosely coupled	• Custom code for each integration need • Suitable for complex integration needs • Tightly coupled	• Standards based integration • Most suitable for inter-organization integration • Loosely coupled	• Suitable for large volumes of data • Generally used to move data between two or more databases
Strengths	• Reliability (guaranteed delivery) • Enables real-time business decisions • Out of box adapters for many enterprise systems	• Familiar technologies and processes • Many point to point integrations already exist • No major up front investment required	• Standards based integration • High degree of reuse • Wide tool support including open source • Low up front investment	• Metadata driven approach • GUI tools for most tasks (little coding) • Extremely efficient for large data volumes
Weaknesses	• High upfront cost • Relatively complex design patterns	• Costly over time • Tight coupling • Scalability issues • Opportunities for reuse are slim	• Lack of transaction support • Not a publishing model • Less established technology	• High upfront costs • Complexity of tool • Batch oriented
When to Use	• Real time data is important • High volume, low footprint data exchange • Many consumers of the same data	• Should be rarely used • When defined enterprise strategy cannot work • Proto typing	• Integration model is request/reply • Real time requirements • High volume, moderate data	• In conjunction with a data warehouse

Audience and Value of the EA Guide

- Project Sponsors and Departmental Leadership
- **Understand institute investments in technology**
- **Understand architectural governance process**
- **Provide technical direction to guide their investments**
- **Provide a way to assess architectural risks on projects**

- IT Architecture Group
- **Common understanding of architecture**
- **Frames architectural review process for projects**
- **Inform gaps in the architecture and where we need to evolve**
- **Provide a way to assess architectural risks on projects**